

THE STATUS OF FRESHWATER CRAYFISH IN SCOTLAND IN THE YEAR 2000

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ABSTRACT

Although no freshwater crayfish are native to Scotland, at least four populations are known to be established here now. Two are of the white-clawed crayfish *Austropotamobius pallipes*, native to England and other parts of Europe and two are of the signal crayfish *Pacifastacus leniusculus*, native to North America. The significance of these populations is discussed.

INTRODUCTION

It is believed that no species of freshwater crayfish is native to Scotland and thus any found here have been introduced from elsewhere. One population has been known in the north of Scotland for many years and recently several other established populations have been identified. The objective of this paper is to assess the populations which have been verified so far and discuss the implications for freshwater habitats and communities in Scotland.

WHITE-CLAWED CRAYFISH

The white clawed crayfish *Austropotamobius pallipes* (Lereboullet) is the only freshwater crayfish which is native to the British Isles and was formerly widespread in England, Wales and Ireland, but not in Scotland. It was also common in many parts of mainland Europe. Many of these populations have now disappeared, largely as a result of crayfish plague and, latterly, competition from alien crayfish. Crayfish plague, which is caused by the fungus *Aphanomyces astaci* Schikora, is thought to have been introduced into Italy in the 1860s from where it rapidly spread throughout Europe, devastating populations of native crayfish, both the white-clawed crayfish and the noble crayfish *Astacus astacus* (Linnaeus), which is native to mainland Europe but not to the British Isles.

Although the white-clawed crayfish is not believed to be native to Scotland, for several decades a population is known to have existed in limestone waters in the Durness area of Sutherland (Thomas, 1992). It is assumed that this population was introduced there early in the 20th Century. Because it is so far from other populations of crayfish this stock has never been affected by crayfish plague. Recent investigations at Durness have revealed that the white-clawed crayfish is still

well established there (D. Mitchell, personal communication).

More recently, another population of white-clawed crayfish has been discovered by one of the authors (PSM) in a small reservoir in the catchment of the lower Clyde (Fig. 1a). According to local people it has been established there for at least 50 years and probably much longer. At the time of initial sampling (13th May, 2000) white-clawed crayfish of all sizes were common along the littoral zone (Fig. 2a) and the population is obviously thriving. As this species is protected in Great Britain (see below), specimens were returned to the water immediately after examination and photographing.

The white-clawed crayfish is listed as an endangered species by the World Conservation Union (IUCN) (Groombridge, 1993) and as globally threatened by Wynne *et al.* (1995). The British Isles now have the largest stocks of this species in Europe (Holdich & Rogers, 1995) where it was once widespread in France, Italy and Spain but is now confined to isolated sites in these countries. In the British Isles too its populations have been declining, mainly due to the impact of non-native crayfish and disease (Holdich & Rogers, 1995). The main threat to *A. pallipes* is crayfish plague which can be carried by the signal crayfish *Pacifastacus leniusculus* (Dana).

The white-clawed crayfish is now protected in Great Britain by its listing in Schedule 5 of the Wildlife and Countryside Act 1981 (which makes it illegal to take it from the wild and to sell it). It is also included in Appendix III of the Bern Convention (this lists protected species where, under certain conditions, some exploitation of their populations is permitted) and Annexes II (species whose conservation requires the designation of Special Areas of Conservation) and V (species whose taking in the wild may be subject to management measures) of the EC 'Habitats and Species' Directive (Boon *et al.*, 1992).

SIGNAL CRAYFISH

The signal crayfish *Pacifastacus leniusculus* (Dana) is an alien species, native to the western states of North America, which was first introduced to Sweden about 1960 and subsequently from there



Fig. 1a

Fig. 1a A live white-clawed crayfish from the new site located in the Clyde catchment.

Fig. 1b Five signal crayfish from the River Clyde showing the wide variation in size among the population there.

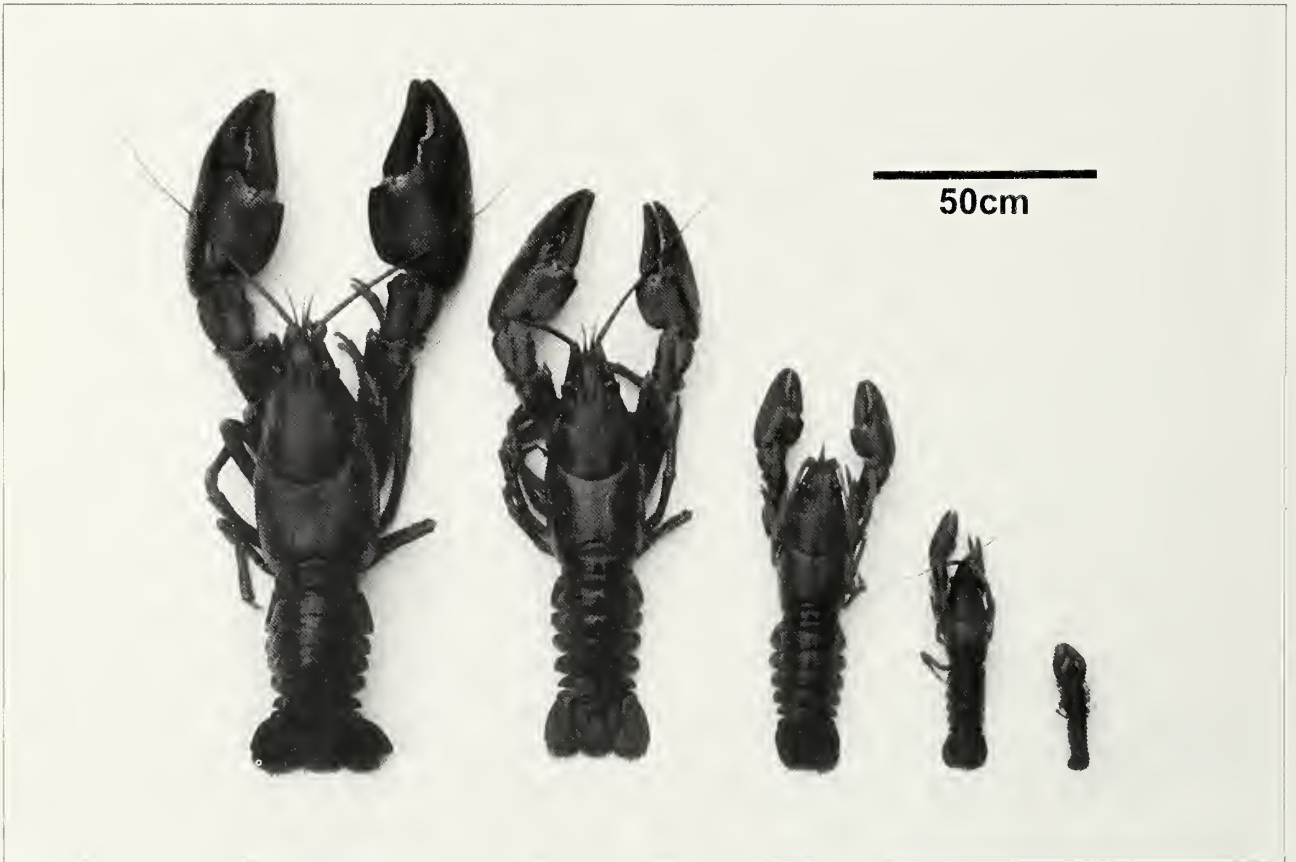


Fig. 1b



Fig. 2a The new site for white-clawed crayfish described in the text.



Fig. 2b The River Clyde at Elvanfoot where signal crayfish are now well established.

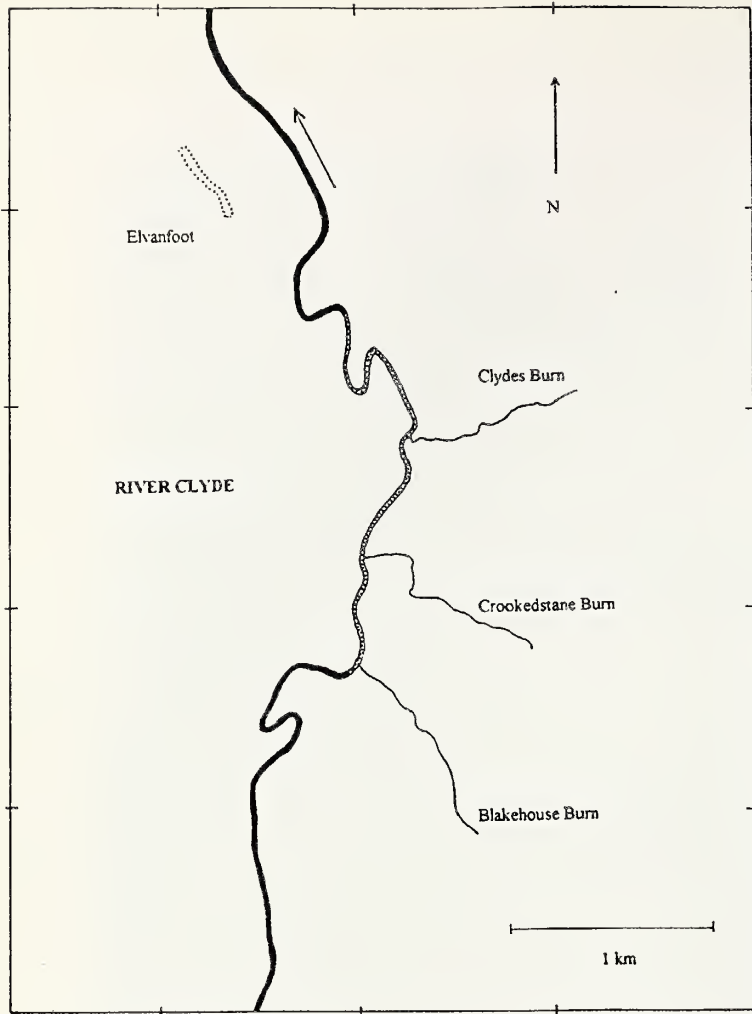
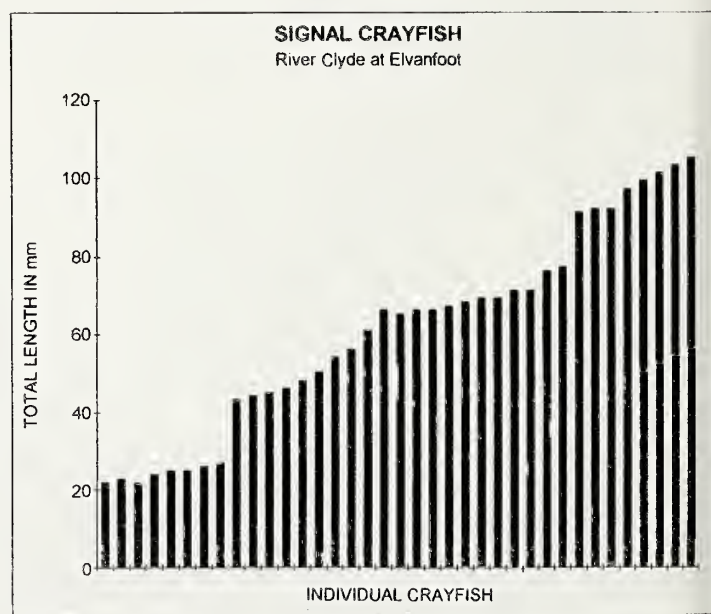
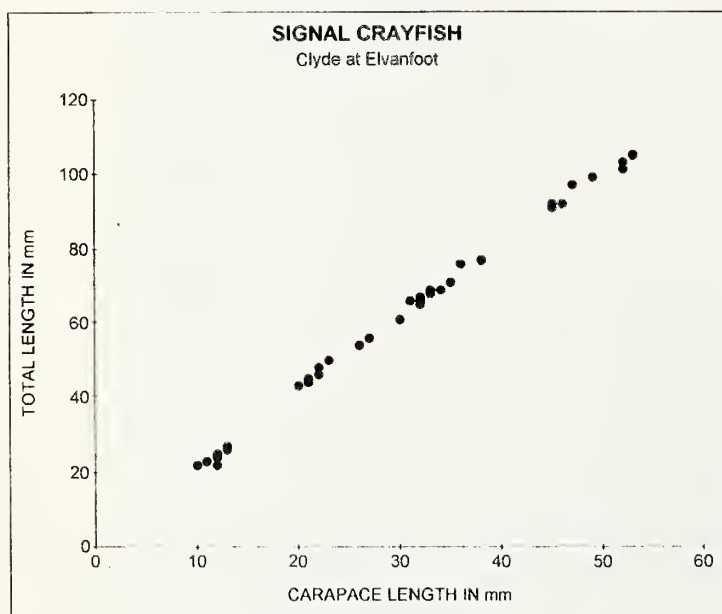


Fig. 3. (left) An outline map of the River Clyde in the Elvanfoot area, showing the distribution of signal crayfish in the year 2000 (stippling).

Fig. 4. (below, left) Relationship between total length and carapace length of signal crayfish from the River Clyde.

Fig. 5. (below, right) Total length distribution of a sample of signal crayfish taken from the River Clyde on 13th May, 2000.



into Great Britain in large numbers since the 1970s (Holdich & Reeve, 1991), mainly for crayfish farming. There are several records of this species having been brought into Scotland (again for crayfish farming) and some are known to have been released here. Localities into which signal crayfish are known to have been brought include Arran, Burntisland, Glasgow, Inverness, Jedburgh, Kirkcudbright, Lochgilphead, Oban, Rothesay and Tayside. Until recently, however, none of these stocks has been known to have become established in the wild. This compares with over 100 successful introductions to waters (both standing and running) in England and Wales, where the species is now well established in many catchments (Holdich & Rogers, 1992). As well as the farmed populations in open ponds, escapes from these crayfish farms in England have also led to many wild populations becoming established there.

The species was recorded recently as being well established at a stream site in southwest Scotland (Maitland, 1996) in the River Dee (Kirkcudbright) catchment where specimens were collected in the summer of 1995. Local information indicated that the species had occurred at this site for several years. Further populations were recorded in summer 1995 and summer 1998 (West Galloway Fisheries Trust, 1996 and 1999) at other sites in the system indicating a more widespread distribution than previously noted. Routine kick sampling by staff from the Scottish Environment Protection Agency (SEPA) further confirmed their presence in the Garple Burn and Water of Ken.

More recent investigations in the River Dee (Kirkcudbright) catchment have confirmed a more widespread distribution in the system (Sinclair & Ribbens, 2000) with stream sites and main river channel locations now utilised by the species. In total, a river length of at least 9.5 km is estimated to be populated by the species. It is also likely that Loch Ken itself is inhabited by crayfish due to the proximity of both stream and main channel crayfish records to this waterbody. It seems likely that further dispersal within the catchment is likely in future years.

In October 1999, the remains of an adult crayfish were found on gravel alongside the upper reaches of the River Clyde near Elvanfoot (Fig. 3) by William Miller, and confirmed by one of the authors (PSM) as a signal crayfish. Subsequently, searches in the river in the same area by William Miller revealed two live juvenile specimens of this species and several other dead specimens on the bank. An otter *Lutra lutra* was seen at the same time and may have been feeding on the crayfish. During a survey by Scottish Natural Heritage (SNH) and SEPA staff on 11th November, 1999, four juvenile signal crayfish were collected, just upstream of the Clydes Burn confluence. A few

adult claws were also found on the river bank in the same area.

On 13th May, 2000, one of the authors and William Miller, using handnets, collected about 30 signal crayfish from the same stretch of river (Figs. 1b and 2b). These were photographed and measured for length. Both carapace and total lengths were measured, but subsequent analysis (Fig. 4) indicated that only one of these measurements is necessary as there is a close linear relationship between the two. The resulting length frequencies (Fig. 5) showed a wide range of size and indicated that at least five year classes were present in the population (Fig. 1b).

The discovery of signal crayfish in the River Clyde has caused great concern among local anglers for reasons which are discussed below, and early in 2000, the United Clyde Angling Protective Association funded a study to investigate means of control and the biology of this species in the area (Trudgill, 2000). This research has accumulated valuable information on the distribution, sex ratios, breeding cycle and numbers of crayfish in the study area and provides a valuable baseline for the future. Crayfish continue to be trapped in the River Clyde and it is estimated that a total of some 10,000 have been removed during the year 2000 (W. Miller, personal communication).

There have been unconfirmed reports of *Pacifastacus leniusculus* from other parts of Scotland. These require verification. However, two specimens of this species were found in 1995 at separate places in the River Earn (B. Clelland, personal communication) and it may well be establishing in other areas.

DISCUSSION

The introduction of crayfish to Scotland is not a new phenomenon. Some 150 years ago, Lord Breadalbane brought 1100 'crawfish' in spawn into Scotland, presumably for introduction to the River Tay (Anonymous, 1862). Crayfish were also put into waters in Lanarkshire, Dunbartonshire, Argyllshire and Renfrewshire around that time. It is possible that the present Clyde and Durness populations of white-clawed crayfish originated from stocks introduced during this period.

The origin of the Clyde population of signal crayfish is uncertain, but it is suspected that an attempt has been made to farm the species locally on a trial basis and the crayfish escaped or were deliberately dumped when the venture was curtailed. The use of crayfish as a bait by coarse fishermen visiting from the south has also been suggested as a possibility.

The release to the wild of signal crayfish is an offence under Section 14 of the Wildlife and Countryside Act 1981. In May 1996 MAFF and the Welsh Office introduced new licensing

requirements for the keeping of non-native crayfish under the terms of the Prohibition of Keeping of Live Fish (Crayfish) Order 1996 and parallel legislation was introduced in Scotland. These Orders are intended to help protect native crayfish populations by preventing the spread of non-native species. They make the unlicensed keeping of non-native species an offence, with the exception of signal crayfish which may be kept without a licence in certain parts of England (but not Scotland), where extensive feral populations have become established.

Two main issues arise from the establishment of these crayfish in Scotland. Firstly, although the population of the white-clawed crayfish in Sutherland is almost certainly introduced, it has considerable conservation value since it provides a valuable safeguard stock in the event of serious problems further south. Durness is several hundred kilometres from the nearest populations in England and has, so far, not been subject to introductions of either alien crayfish species nor the crayfish plague which is often introduced with them (Holdich, 1988; 1991). The population of white-clawed crayfish in the lower Clyde area is much less safe, particularly now that signal crayfish are established in the upper Clyde.

Secondly, as far as the signal crayfish is concerned, it is clear that Scotland is no longer free from this aggressive and invasive species. It is known that the introduction of non-native crayfish can have profound effects on aquatic ecosystems, quite apart from the threat it poses to the native species (Palmer, 1994). Signal crayfish are large omnivores and can cause major changes in local flora and fauna through grazing and predation. They can also cause damage to river banks by burrowing, increasing erosion and having indirect effects on flora and fauna through habitat degradation. On a more positive note they do provide food for otters (crayfish remains have been found in otter spraints on the Clyde) and some fish - though it must be remembered that such crayfish (usually small ones) have already eaten what would be the normal invertebrate food of these fish.

The statutory nature conservation agencies recommended that 'if and when suitable control measures are developed, eradication of non-native crayfish populations should be attempted by the appropriate authority or individual, where the introduced species threatens particularly sensitive sites' (Palmer, 1994). Crucial to the effective deployment of a control strategy for additional crayfish populations identified in Scotland is the early notification of the presence of the species. Such reporting is encouraged in England and Wales by the Environment Agency (EA) (Holdich & Rogers, 1999) where a national database and regional recording structure is present. At the moment there is no such system promoted in Scotland but it is hoped that a media campaign to

raise awareness of the issue will be promoted by SNH and SEPA.

Although this eradication of crayfish populations is an ideal, and something which may be possible if small populations are detected early enough (Maitland, 1996) it is obviously a difficult task when stocks are fully established. Crayfish removal studies completed using electrofishing techniques in the River Dee (Kirkcudbright) catchment have indicated that this method is capable of removing large numbers of specimens of all age and length classes but that total eradication is not achievable when an established population is encountered (Sinclair & Ribbens, 2000). Other strategies such as mechanical removal via trapping and biological, physical and chemical control techniques are unlikely to be appropriate or effective in many situations due to environmental, resource and technological constraints. However, the EA is currently funding a research project on the eradication of alien crayfish populations, mostly involving mechanical methods, though at least one trial using biological control (stocking with eels *Anguilla anguilla* and chub *Leuciscus cephalus*) is proposed. The easier solution is to try to prevent alien animals ever reaching Scotland in the first place, through both legislation and education.

The stream and main channel sites known to contain crayfish in Galloway lie within the catchment of the Water of Ken above Loch Ken. It is likely that the species is now present in the larger waters of the loch and the River Dee downstream. Both of these systems offer apparently suitable habitats for the species and it seems likely that there may be further extensions to existing populations in future years. Although the rate of spread in the River Dee is presently unquantified the species is invasive and has been found to spread in rivers at a rate of approximately 1 km/year (Holdich *et al.*, 1995).

Further spread of the population in the upper Clyde area is also likely as dispersal through much of this large catchment would appear to be straightforward. Routine biological sampling by SEPA at a site above Elvanfoot Bridge has never detected crayfish in the past, but it seems likely that signal crayfish will be recorded here before too long. The present limits of distribution appear to be from the confluence of the Blakehouse Burn downstream to about one kilometre below Clydes Burn, with some dispersion into the lower reaches of these burns and the Crookedstane Burn (Fig. 3).

Further research on, and monitoring of, all these populations - both white-clawed and signal crayfish - is of some immediate importance in order (a) to determine stock size and observe any geographic dispersal, (b) to analyse their ecological performance in comparison with that of populations further south, and (c) to assess the

nature and status of the native populations of plants, invertebrates and fish in the waters concerned. Such studies will provide essential baseline information from which to assess the rate of spread and impact on local habitats, especially where signal crayfish are established, for this species has the reputation of being both invasive and aggressive. It is known that population growth can be rapid under suitable conditions and that this crayfish can soon become the dominant invertebrate (Holdich & Reeve, 1991). Eradication measures of some kind are probably too late now and it seems likely that signal crayfish may become as successful an invader in the Galloway and Clyde systems as has the ruffe *Gymnocephalus cernuus* in Loch Lomond (Maitland *et al.*, 1983) over the last decade.

It is to be hoped that further irresponsible introductions to Scotland can be prevented in the future (Maitland, 1987). In England, not only is the signal crayfish well established in numerous waters, but the noble crayfish - an alien species native to parts of continental Europe - is now established at one location in the Mendips (Holdich & Rogers, 1999).

ACKNOWLEDGEMENTS

The Clyde population of signal crayfish was first discovered by William Miller, whom we thank for his help and advice. We are grateful also to Brian Clelland, William Duncan and Donald Mitchell for information regarding the current status of some of the populations discussed in this paper. Helpful comments on an earlier draft were received from Dr Roger Downie and an unknown referee.

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